

IN THE CLAIMS

What is claimed is:

1. A pressure wave apparatus, comprising:

a rotatable rotor having a plurality of passageways therethrough, said rotor having a direction of rotation,

a pair of exit ports disposed in fluid communication with said rotor and adapted to receive fluid exiting from said plurality of passageways, one of said pair of exit ports is a combusted gas exit port for passing a substantially combusted gas from said plurality of passageways and the other of said pair of exit ports is a buffer gas exit port for passing a buffer gas from said plurality of passageways;

a pair of inlet ports disposed in fluid communication with said rotor and adapted to introduce fluid to said plurality of passageways, one of said pair of inlet ports is a working fluid inlet port for passing a working fluid into said plurality of passageways and the other of said pair of inlet ports is a buffer gas inlet port for receiving the buffer gas from said buffer gas exit port and passing the buffer gas into said plurality of passageways, said buffer gas exit port is adjacent to and sequentially prior to said buffer gas inlet port; and

a fuel deliverer adapted to deliver a fuel within said buffer gas exit port adjacent the rotatable rotor, wherein said fuel deliverer delivers fuel into a first portion of said buffer gas exit port and not into a second portion of said buffer gas exit port.

2. The pressure wave apparatus of claim 1, wherein said second portion includes a leading portion of said buffer gas exit port.

3. The pressure wave apparatus of claim 2, wherein said leading portion is the initial about fifteen percent of said buffer gas inlet port.

4. The pressure wave apparatus of claim 1, wherein said second portion includes a leading portion of said buffer gas inlet port and a last portion of said buffer gas inlet port.

5. The pressure wave apparatus of claim 4, wherein said leading portion is defined by the initial about fifteen percent of said buffer gas inlet port and said last portion is defined by the last about ten percent of said buffer gas inlet port.

6. The pressure wave apparatus of claim 1, wherein said fuel deliverer includes a plurality of fuel delivery devices spaced across said buffer gas inlet port, and wherein at least a portion of said plurality of fuel delivery devices are controllable to selectively deliver fuel.

7. The pressure wave apparatus of claim 1, which further includes a passageway between said buffer gas exit port and said buffer gas inlet port, and wherein said passageway is adapted to deliver the buffer gas from said buffer gas exit port to said buffer gas inlet port in said direction of rotation.

8. The pressure wave apparatus of claim 1, wherein the fuel and the working fluid is detonated within said plurality of passageways.

9. The pressure wave apparatus of claim 1, wherein said second portion is defined by a leading portion of said buffer gas inlet port and a last portion of said buffer gas inlet port; wherein said fuel deliverer includes a plurality of fuel delivery devices spaced across said buffer gas inlet port and adapted to deliver fuel into the buffer gas flowing through said first portion; and wherein the fuel and the working fluid within at least one of said plurality of passageways is detonated.

10. The pressure wave apparatus of claim 9, wherein the buffer gas is formed by compressing a portion of the working fluid within said plurality of passageways; which further includes an igniter disposed in communication with the fuel and working fluid within said at least one of said plurality of passageways, and wherein said igniter being operable to initiate the detonation of the fuel and working fluid within said at least one of said plurality of passageways.

11. The pressure wave apparatus of claim 10, wherein said rotor having a first end and an opposite second end; wherein said buffer gas exit port and said pair of inlet ports are located adjacent said first end, and said combusted gas exit port is located adjacent said second end; and wherein said buffer gas inlet port is adjacent to and sequentially prior to said working fluid inlet port.

12. A method, comprising:

- (a) rotating a wave rotor having a passageway with a first end and a second end;
- (b) introducing a quantity of working fluid into a passageway through the first end of the passageway;
- (c) delivering a quantity of fuel into the passageway through the first end of the passageway;
- (d) burning the fuel within the passageway and creating a combusted gas;
- (e) compressing a portion of the working fluid within the passageway to define a buffer gas;
- (f) discharging a first portion of the buffer gas from the passageway through the first end of the passageway;
- (g) discharging a portion of the combusted gas from the passageway through the second end of the passageway;
- (h) parking a second portion of the buffer gas within the passageway at the first end; and
- (i) routing the first portion of the buffer gas from said discharging back into the passageway through the first end of the passageway.

13. The method of claim 12, wherein at least a portion of said rotating is accomplished by an independent drive operatively coupled with the wave rotor.

14. The method of claim 12, wherein said parking facilitates balancing of the fluid flow into and out of the passageway.

15. The method of claim 12, wherein the wave rotor having a plurality of passageways, and which further includes repeating acts (a) – (i) for each of said plurality of passageways.

16. The method of claim 12, wherein said burning is defined by a detonative combustion process;

wherein said wave rotor rotates in a first direction; and

wherein said routing is in the direction of the rotation of the wave rotor.

17. The method of claim 16, wherein said delivering occurring to the first portion of the buffer gas during said routing; and

wherein said delivering provides the quantity of fuel to only a first part of the first portion of buffer gas and does not provide fuel to a second part of the first portion of the buffer gas.

18. The method of claim 12, wherein said rotating includes a start up phase and during the start up phase at least a portion of said rotating is accomplished through an independent drive operatively coupled with the wave rotor;

wherein the rotor includes a plurality of passageways, and acts (a) – (i) are repeated for each of said plurality of passageways;

wherein said rotating is in a first direction;

wherein said rotating is in the first direction; and

wherein said burning is defined by a detonative combustion process within each of the plurality of passageways.

19. The method of claim 18, wherein said delivering occurring to the first portion of the buffer gas during said routing, and said delivering introduces the quantity of fuel to only a first part of the first portion of the buffer gas and a second part of the first portion of the buffer gas does not have fuel introduced therein by said delivering.

20. A method for starting a gas turbine engine, comprising:

- (a) providing an engine including a compressor, a combustor including a wave rotor having a plurality of passageways and a turbine;
- (b) rotating the wave rotor;
- (c) fueling at least a portion of the plurality passageways;
- (d) combusting the fuel within the plurality of passageways to form a flow of exhaust gas;
- (e) discharging at least a portion of the exhaust gas from the wave rotor and delivering to a bladed rotor within the turbine;
- (f) rotating the bladed rotor within the turbine with the exhaust gas from said discharging; and
- (g) repeating acts (a) – (f) to bring the compressor and turbine up to an operating condition.

21. The method of claim 20, wherein said repeating continues to start the gas turbine engine.

22. The method of claim 20, wherein said combusting is defined by detonative combustion.

23. The method of claim 20, which further includes providing an independent drive operative coupled with the wave rotor; and wherein at least a portion of said rotating occurring through the independent drive.

24. The method of claim 23, which further includes supporting the wave rotor with electromagnetic forces, and wherein the at least a portion of said rotating includes controlling the electromagnetic forces to cause said rotating.

25. The method of claim 20, which further includes introducing a working fluid into the combustor, wherein the combustor is a substantially constant volume combustor;
which further includes providing a drive operatively coupled with the wave rotor;
wherein said combustor is defined by detonative combustion;
wherein said rotating includes a start up portion wherein the wave rotor is driven by the drive;
which further includes providing at least one electromagnetic radial bearing; and
which further includes supporting the wave rotor with the at least one electromagnetic radial bearing.

26. An apparatus, comprising:

a compressor for increasing the pressure of a working fluid passing therethrough, said compressor having a compressor discharge;

a constant volume combustor in fluid communication with said compressor discharge, said constant volume combustor including a rotatable wave rotor and a fuel deliverer, said wave rotor including a plurality of cells for receiving at least a portion of the working fluid from said compressor discharge and a fuel from said fuel deliverer that undergoes combustion within said cells to produce an exhaust gas flow;

a turbine in flow communication with the exhaust fluid flow from said constant volume combustor; and

at least one active electromagnetic radial bearing operable to support said wave rotor.

27. The apparatus of claim 26, wherein the portion of the working fluid and the fuel undergo detonative combustion within said plurality of cells.

28. The apparatus of claim 26, wherein said wave rotor includes a first structure defining the cells and an attachment structure coupled thereto, and wherein said attachment structure engages with said at least one active electromagnetic radial bearing about which said wave rotor rotates, and wherein said first structure is coupled to said attachment structure by pin join means for coupling and thermally isolating said first structure from said at least one active electromagnetic radial bearing.

29. The apparatus of claim 28, which further includes a first end plate and a second end plate for controlling the passage of fluid relative to said plurality of cells, and wherein said

rotor has a first end spaced a first gap from said first end plate and an opposite second end spaced a second gap from said second end plate, and wherein said first gap and said second gap are filled with a high pressure working fluid bled from said constant volume combustor.

30. A method, comprising;
 - providing a gas turbine engine including a compressor, a constant volume combustor including a wave rotor, and a turbine, the wave rotor including a passageway having a first end and a second end;
 - rotating the wave rotor;
 - introducing a quantity of working fluid into the passageway through the first end of the passageway;
 - delivering a quantity of fuel into the passageway through the first end of the passageway;
 - detonating the fuel and a portion of the working fluid within the passageway to create a combusted gas;
 - creating waves within the passageway to compress a portion of the working fluid within the passageway to define a buffer gas;
 - discharging a first portion of the buffer gas from the passageway through the first end of the passageway and rerouting the first portion of the buffer gas from said discharge back into the passageway through the first end of the passageway;
 - discharging a portion of the combusted gas from the passageway through the second end of the passageway to the turbine; and
 - expanding the portion of the combusted gas within the turbine.

31. An apparatus, comprising:

a compressor for increasing the pressure of a working fluid passing therethrough, said compressor having a compressor discharge;

a constant volume combustor in fluid communication with said compressor discharge, said constant volume combustor including a rotatable wave rotor and a fuel deliverer, said wave rotor including a plurality of cells for receiving at least a portion of the working fluid from said compressor discharge and a fuel from said fuel deliverer that undergoes combustion within said cells to produce an exhaust gas flow;

a turbine in flow communication with the exhaust fluid flow from said constant volume combustor;

at least one radial bearing operable to support said wave rotor; and wherein said wave rotor includes a first structure defining the cells and an attachment structure coupled thereto, said attachment structure engages with said at least one radial bearing about which said wave rotor rotates, said first structure is coupled to said attachment structure by a pin joint, said pin joint coupling and thermally isolating said first structure from said at least one radial bearing.

32. The apparatus of claim 31, wherein the portion of the working fluid and the fuel undergo detonative combustion within said plurality of cells.

33. The apparatus of claim 31 wherein said wave rotor includes a first end and a second end and which further includes sealing means for filling the gap adjacent one of said ends with a pressurized fluid.